Numb. 67.

PHILOSOPHICAL TRANSACTIONS.

Januar. 16. 16$\frac{70}{71}$.

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An Accompt of ſundry Experiments made and communicated by that Learn'd Mathematician, Dr. Eraſmus Bartholin, *upon a Chryſtal-like Body, ſent to him out of* Iſland.

BEfore we come to the Relation it ſelf of theſe Experiments, we cannot but premiſe an *Extract* of the Obliging Letter, written to the Publiſher, by the ſaid Doctor *Bartholin* from *Copenhagen* Febr. 27. 1670; Engliſh't as follows;

——I Know the many Excellencies of the Engliſh Nation, and that innumerable new things in the matter of knowledge iſſue thence, and diffuſe themſelves through *Europe*; though they arrive ſomewhat ſlowly hither. We are here preſſed with ſo many cares, that though we want no will to contribute ſomething to the advancement of knowledge; yet being deſtitute of the leiſure neceſſary for it, and diverted by two difficult Profeſſions, the Medical and Mathematical, we can rather admire the performances of others, than engage for any thing of our own. But yet, not altogether to fruſtrate your expectation, and to give you ſome Teſtimony of my affection and endeavors, I here ſend you ſome Experiments made with a certain Chryſtal-like Stone, ſent me out of *Iſland*, together with a piece of that Stone, to make the Tryals your ſelf. Farewell.

For the reſt, we are now labouring to publiſh a more corrected and better digeſted Edition of *Tycho Brahe's* Works; a buſineſs of much time and exceeding great labour: Which care while I am engaged in, I muſt lay aſide other matters. Yet I hope, that my part in this work will ſhortly be over; there remaining almoſt nothing, but to provide the charges neceſſary for the Impreſſion; which all true Lovers of Aſtronomy cannot but have a great concern for

This Letter being ſent to *Hamborough* to that Ingenious Phyſitian, Dr. *Matthias Paiſenius*, with a deſire to tranſmit it to *London*, this worthy Perſon was pleaſed to incloſe it in one of his, written to the Publiſher; which, ſince it treateth of the ſame argument (I mean, the *Iſlandian* Stone,) will not be amiſs to ſubjoyn here the Breviate of.

——*The Obſervations of the Excellent* Bartholin *upon the* Iſland-Chryſtal *are indeed conſiderable as well as painfull. We have here alſo made ſome Tryals of it upon a piece, he preſented me with; which confirm his obſervations. Mean time, we found it ſomewhat ſciſſile and reducible by a knife into thin* lamina's *or plates, which, when ſingle, ſhew'd the Object ſingle, but laid upon one another, ſhew'd it double; the two images appearing the more diſtant from one another, the greater the number was of thoſe thin plates laid on one another. With ſubmiſſion to better judgements, I think it to be a kind of* Selenites. *Some of our curious men here were of opinion, that the* Rhomboid *figure, proper to this Stone, was the cauſe of the appearances doubled thereby. But having tryed, whether in other Tranſparent Bodies, of the like Figure, the like would happen, we found no ſuch thing in them; which made us ſuſpect ſome peculiarity in the very Body of this Stone.*

Theſe Letters being thus premiſed, we now come to relate the Brief of the Obſervations and Experiments themſelves; referring the more Curious Reader to the larger Accompt of them, and their Mathematical Demonſtrations, as they are to be found in the Printed Book, entitul'd *Eraſmi Bartholini Experimenta Chryſtalli Iſlandici Diſ-Diaclaſtici; quibus mira & Inſolita* REFRACTIO *detegitur.* Hafniæ A. 1669.

1. The Inhabitants of *Iſland* and our own Merchants inform us, *that* this kind of Chryſtal is found in divers places of that Country; but chiefly digg'd out of a very high mountain, not far from the Bay of *Roerfiord*, which lies in 65. degr. *Latitude*; *that* that Mountain reacheth Southward, and hath its whole outſide made up of this ſubſtance, without a neceſſity of digging deep for it; *that* it is cut out by Iron-tooles, in bigneſs of a Cubick foot, or ſomewhat better: and *that* out of its corners there is ſometimes found grown out a harder matter, not unfit to cut glaſs, of a figure different from that of the whole maſs, and approaching to that of Diamonds.

2. The Figure of this Chryſtal ſtone is like a *Rhombick* or *Rhomboid Priſme.* Nor hath the whole Body that Figure only, but all the parts of it, when broken into ſmall pieces, keep the ſame; except that in ſome caſes the ground, whence 'tis digged, yields ſuch as are of a Triangular Pyramid-figure.

3. This Subſtance is Electrical, attracting (to ſpeak with the Vulgar,) when heated, ſtraw, Feathers, &c.

4. It is not ſo hard, as to endure poliſhing: Nor is it eaſily conſumed; nor reduced into a *calx* but by a ſtrong fire, by which it will turn into a ſubſtance like unſlaked lime, which will heat a wet finger, and, when ſprinkled with fountain-water, will buble up, and become like common lime.

5. *Aqua fortis* being by me dropp'd upon it, it was corroded, and the ſuperficial parts were put into a motion with ſome noiſe. And when I pulverized it in a mortar, Aqua fortis, powred on it, made it boyle, till all was diſſolved, and the *Menſtruum* tinged with a yellowiſh colour. Then putting it into a Thermometer furniſht with a hollow glaſs-ball, it conſiderably ſhew'd the difference of Heat and Cold. The powder being diſſolv'd in *Aqua fortis*, I dropp'd ſome Spirit of *Vitriol* upon it, to ſeparate the thick from the thin, and to precipitate the white *calx* to the bottom.

6. The ſides of this Body are exceeding ſmooth; which is then eaſily obtained, if a thinner piece be nimbly broke aſunder with your finger. But if you ſtrike it with a hammer, the percuſſion hath not the ſame effect upon, nor is equally reſiſted from every part; whence the ſmooth ſides of this Mineral become often ſcabrous. The whole Body is rather clear than bright, of the colour of limpid water; but that colour, when it hath been immerſed in water and dryed again, becomes dull. Hence it is, that in its native place the upper ſurface is darkiſh; becauſe of the Rains and Snows fallen upon it. Sometimes there appear alſo ſome reflections of colours, as in the Rain-bow. The Angles are not pointed alike, all the flat ſides being obliquely inclined to one another. The oppoſite plains are parallel.

7. In this Chryſtallin Priſme, two of the plain Angles are always acute, and the two other obtuſe; and never any of them is equal to the collateral Angles of the Inclinations.

8. The Objects ſeen through it, appear ſometimes, and in certain poſitions of the Priſme, double: Where 'tis to be noted, that the diſtance between the two images is greater or leſs, according to the different bigneſs of the Priſme; inſomuch that in thinner pieces this difference of the double image almoſt vaniſheth.

9. The Object appearing double, both images appear with a fainter colour; and ſometimes one part of the ſame *ſpecies* is obſcurer than the other.

10. To an attentive Eye, one of theſe Images will appear higher than the other.

11. In a certain poſition the Image of an Object, ſeen through this Body, appears but ſingle, like as through any other Tranſparent Body.

12. We have alſo found a poſition, wherein the Object appears ſixfold.

13. If any of the obtuſe Angles of this Priſme be divided into two equal parts by a line, and the viſual rays do paſs from the Eye to the Object through that line, or its parallel, both Images will meet in that line, or in another parallel to it.

14. Whereas Objects, ſeen through Diaphanous Bodies, are wont to remain conſtantly in the ſame place, in what manner ſoever the tranſparent Body be moved, nor the Image on the Surface move except the Object be moved; we have obſerved here, that one of the Images is moveable, the other remaining fix; although there be a way alſo, to make the fixed image moveable, and the moveable fix in the ſame Chryſtal; and another, to make both moveable.

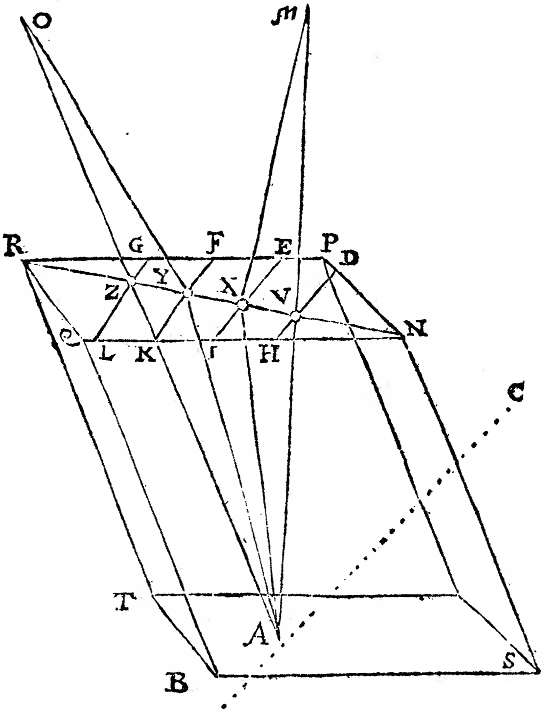
15. The *Moveable* Image doth not move at random, but always *about* the *Fixed*, which while it turneth about, it never deſcribeth a perfect Circle but in one caſe.

16. *Dioptricks* teach, that a Diaphanous Body, having one only ſurface, ſends from one Object but one Image refracted to the Eye; and having more Surfaces than one, it repreſents one Image in each; But whereas in our ſubſtance there occurs but one plain ſuperficies to the Eye and yet a double image of one Object; it concern'd us to conſider, whence this double image might be cauſed. *Two* ways offer'd themſelves to us, *Reflection* and *Refraction*. How *Reflection* could perform it, was difficult to find. For, having dulled the clearneſs of the two plain ſides of our Chryſtallin Priſme, thereby to make them unfit for Reflecting the light; the Rays being directed through its upper and lowermoſt ſuperficies, the image

ſtill appear'd double. Again,two *ſpecies* appearing through a great Priſme,upon breaking of the ſame into pieces and ſo reducing it into divers ſmaller ones, it came to paſs,that through each of theſe leſſer portions the ſame object was ſeen always double. Whence I Collected, that if it ſhould be ſaid, that *one* of the images proceeded from the Reflection of the plain *ſides*; the former of theſe Experiments would diſcountenance that aſſertion. But then if another ſhould derive the cauſe from ſome internal Reflection of the Surfaces of this Body, certainly the ſame effect would not have been found in every one of its parts, but the double appearance, that was exhibited in the ſmalleſt portion, would have been multiplied in a greater bulk.

Reflection therefore not ſatisfying, we recurred to *Refraction.* But, whereas 'tis known,that no image can paſs through two Diaphanous Bodies of a different nature, but by Refraction, and that one image ſuppoſeth one Refraction; it did follow, that,if Refraction were made the cauſe of this *Phænomenon*,there would be a double Refraction for a double image. And, foraſmuch as the Appearances of our *Iſland*-Chryſtal are not of the ſame kind, but one of them is fixt,the other moveth, we ſhall alſo diſtinguiſh the Refractions themſelves, which refract the double Rays arriving to the Eye, and call the one, which ſends the *Fixt* image refracted to our ſight, *Uſual*; the other,which tranſmits the *Moveable* to the Eye, *Un-uſual.* And hence, namely, from this peculiar and notable propriety of the double Refraction in this Iſland-ſtone, we have not ſcrupled to call it *Diſ-diaclaſtick.*

This being ſuppoſed, it will not be irrational to ſuſpect, that theſe two Refractions proceed from different principles. For, ſince it is commonly known from *Dioptricks*, that an Object, by viſual rays affecting the Eye, exhibits ſome Image on the *Superficies* of the Diaphanous Body, which Image is but one, as long as the *Superficies* is one, and the upper plain parallel to the lower; as alſo, that if, the Eye remaining ſteady, the Diaphanous Body be moved, that image remains always fixt, as long as the Object, whence it comes, remains unmoved. Wherefore in this Tranſparent ſubſtance, the Image which appears fixt, may proceed according to the ordinary Laws of *Uſual* Refraction ; but that, which moveth, and is carried about according to the motion of the Diaphanous Body, while the Object remains un-ſtirr'd, ſheweth an *Un uſual* kind of Refraction, hitherto un-obſerved by *Dioptricians*.



Hence, that I might examine the nature and difference of both, I put, upon ſome Object, as the point A, the Priſme of my Double refracting Chryſtal N, P, R, Q, T, B, S; and the Eye M, being perpendicularly poſited over the upper plain of the Priſme N, P, R, Q, I noted, whether there was any Refraction of the point A, (for the *uſual* Laws of Refraction teach, that there is none.) But the Perpendicular Ray of the Eye was obſerved to paſs not through the *Moveable* but the *Fixed* Image; thereby being conformable to the Rules of *Uſual* Refraction, as ſtriking the Eye unrefracted, ſo that the Eye, the Image, and the Object, were ſeen in the ſame Line. But, when in the ſame ſcite of the Eye, the Object A, did alſo exhibit the other Image X, at no ſmall diſtance from the former; I took notice, that this Object A, was not ſeen unrefracted by the means of the image X, though the Eye M, remain'd perpendicular over the plain; and that conſequently this *Un-uſual* Refraction is not ſubject to the received Axiome of *Dioptricks*, which imports, *That a Ray falling* perpendicularly *on the ſuperficies of a Diaphanous Body, is not refracted, but paſſeth unrefracted.*

Next, I ſo placed the Eye in O, that the Ray from the Object A, arriving to the Eye, might be parallel to the lines RT and Q B, of the plane R, Q, T, B, &c. then it appear'd, that the Rays were trajected from the Object A, without Refraction, through the *Moveable* image Q; the Object A, the moveable image Z, and the Eye O, being in the ſame line; and that the ſame Object A, did tranſmit to the Eye O, remaining in the ſame poſition, yet another *ſpecies* Y; through the Refracted Ray AYO Whence it was manifeſt to me, that this *Un-uſual* Refraction had for its Rule the *Parallel* of the *Sides* of this Double-refracting Chryſtal, while the *Uſual* Refraction was directed according to the *Perpendicular* of the *Superficies.*

But conſidering that the place of the point, appearing through our Diaphanous Body, cannot eaſily be determin'd, as being only obvious in the uppermoſt part; we ſhall add the way, whereby we have found its diverſity, by drawing, on the ſubjacent table, a ſtraight line through that point; the place of which line will be determined by the one Eye *through* this Chryſtal, and by the other Eye *without the* Chryſtal. For, in the ſame *Figure*, let through the Object A, be drawn upon the Table, a ſtrait line BC. The Eye being in M, that double line H D, and I E, will appear, the *ſpecies's* being caſt on the upper ſurface: And if you attend well, you will obſerve one of the Images, *viz.* the Fixt H D to be congruent to the ſubjacent line B C, whil'ſt the other, namely the Moveable E I, tendeth towards R. But, if afterwards the Eye be poſited in O, the ſame Object, I mean the line B C, will not only be repreſented double by the images K F, and L G; but alſo the Movable Image G L be congruent to the inferiour line B C; while the Fixed F K is not ſo, but tends towards N.

After the Author hath given us theſe Experiments, he undertaketh to determine the *Quantity* of the Refractions in this Double-refracting Body; and haveing firſt given the *Demonſtration* of the Method of Meaſuring the Refraction of *Glaſs*, (omitted by *Des-Cartes* in his *Dioptricks*,) he finds, after ſeveral Tryals, the Angle of Inclination to the Angle of Refraction in this *Iſland*-Chryſtal to be as 5 to 3.

But this Ingenious Perſon doth not ſtop here, but proceeds to *demonſtrate* all the recited Experiments; obſerving firſt, that the Teachers of the *Corpuſcularian* Hypotheſis, which includeth that of *Figures* and *Pores*, could not wiſh for a fitter Body, than this, to aſſert their Doctrine; in regard that it appears, firſt, that this Double-refracting Body hath its Pores according to the *Ductus* of the ſides, and parallel therereto; ſince it may be obſerv'd, that, according to this diſpoſition of the ſides, it is broken, and the parts ſever'd from one another; and that one of the Images, namely the *Moveable*, paſſeth through them. Next, beſides theſe Pores, lying according to the Paralleliſme of the ſides, it hath others, ſuch as Glaſs, Water, and right Chryſtals have, through which the *Fixt* Image is tranſmitted.

But paſſing by theſe, our Author aſſumeth two *Hypotheſes*, as neceſſary to his deſign, not ſo much found out by Ratiocination, as by the above related Experiments. The one is, that there are ſome Lines, by which the Rays paſs through the tranſparent Body un-refracted; which Lines though they have been held to be Perpendicular in Diaphanous Bodies hitherto known, yet this Author requireth not, that they ſhould be always ſuppoſed ſuch, ſince they may perhaps in ſome caſe be not ſuch. The *other* is, that it may be ſuppoſed, that half the light or appearance, diffuſed from the Object, is refracted according to the *Uſual* Refraction; but the other half according to the *Un-uſual* Refraction; or, which is all one, that the Uſual and Un-uſual Refraction have the ſame power to refract the Rays of the Objects. The former of theſe Suppoſitions he collects from Exper. 14; the latter from Exp. 8. But, how he proceeds in theſe *Deductions*, and the thereon grounded *Demonſtrations*, may be more fully and more plainly ſeen in the above-mentioned *Tract* it ſelf, than can be conveniently deliver'd in this *Epitome.*

An Extract of a Letter from a Learned French Gentleman, concerning a way of making Sea-water ſweet.

MOnſieur *Hauton* hath now declared his ſecret of making Sea water ſweet. It conſiſts *firſt* in a *Precipitation*, made with Oyl of Tartar, which he knows to draw with ſmall charges. *Next*, he *diſtills* the Sea-water; in which work the Furnace taketh up but little room, and is ſo made, that with a very little wood or coal he can diſtill 24 pots of water in a day: For the cooling of which, he hath this new invention, that inſtead of making the *Worm* paſs through a Veſſel full of water (as is the ordinary practiſe,) he maketh it paſs through one hole, made on purpoſe out of the Ship, and to enter in again through another: So that the Water of the Sea performeth the cooling part: By which means he ſaveth the room, which the common *Refrigerium* would take up; as alſo the labour of changing the Water, when the *Worm* hath heated it. But then *thirdly*, he joyns the two precedent Operations, *Filtration*, thereby perfectly to correct the malignity of the Water. This Filtration is made by means of a peculiar Earth, which he mixeth and ſtirrs with the diſtilled water, and at length ſuffers to ſettle at the bottom. *Paris* Febr. 22. 1670.